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Bednarz et al.

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(54) **BRACKET FOR AN AFTER-TREATMENT COMPONENT**

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(51) **Int. Cl.**

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A47B 96/06	(2006.01)
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F16M 13/02	(2006.01)
F01N 13/00	(2010.01)

(52) **U.S. Cl.**

CPC ***F01N 13/1822*** (2013.01); ***F01N 13/1855*** (2013.01); *F01N 13/00* (2013.01); *F01N 13/1844* (2013.01); *F16M 13/02* (2013.01)

(58) **Field of Classification Search**

CPC F01N 13/1805; F01N 13/1811; F01N 13/1822; F16M 13/02

USPC 248/205.1, 567, 638, 676; 60/322

See application file for complete search history.

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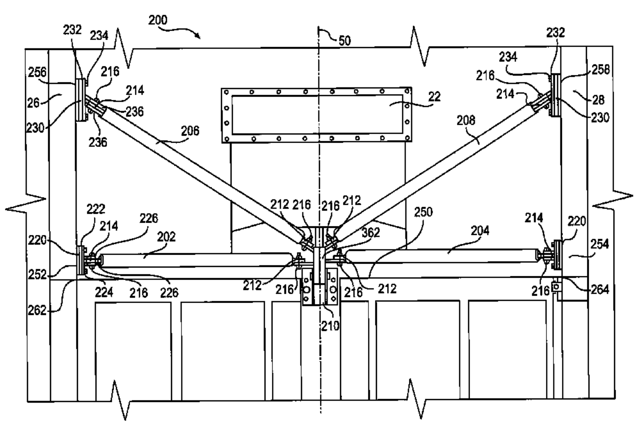
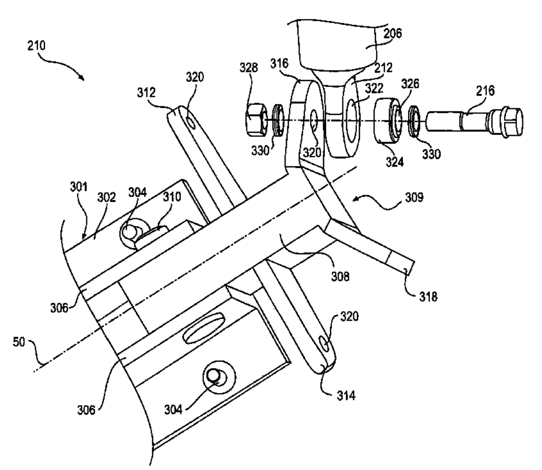
(57) **ABSTRACT**

A bracket for connecting an after-treatment component to a frame is disclosed. The bracket may have a clevis connectable to the after-treatment component. The bracket may also have a front link coupler. The front link coupler may have a tang connected to the clevis. The front link coupler may also have a first flange extending outward from the tang and a second flange extending outward from the tang opposite the first flange. In addition, the front link coupler may have a third flange spaced apart from the first flange and extending outward from the tang and a fourth flange spaced apart from the second flange and extending outward from the tang opposite the third flange. The first, second, third, and fourth flanges may be connectable to the frame.

18 Claims, 8 Drawing Sheets





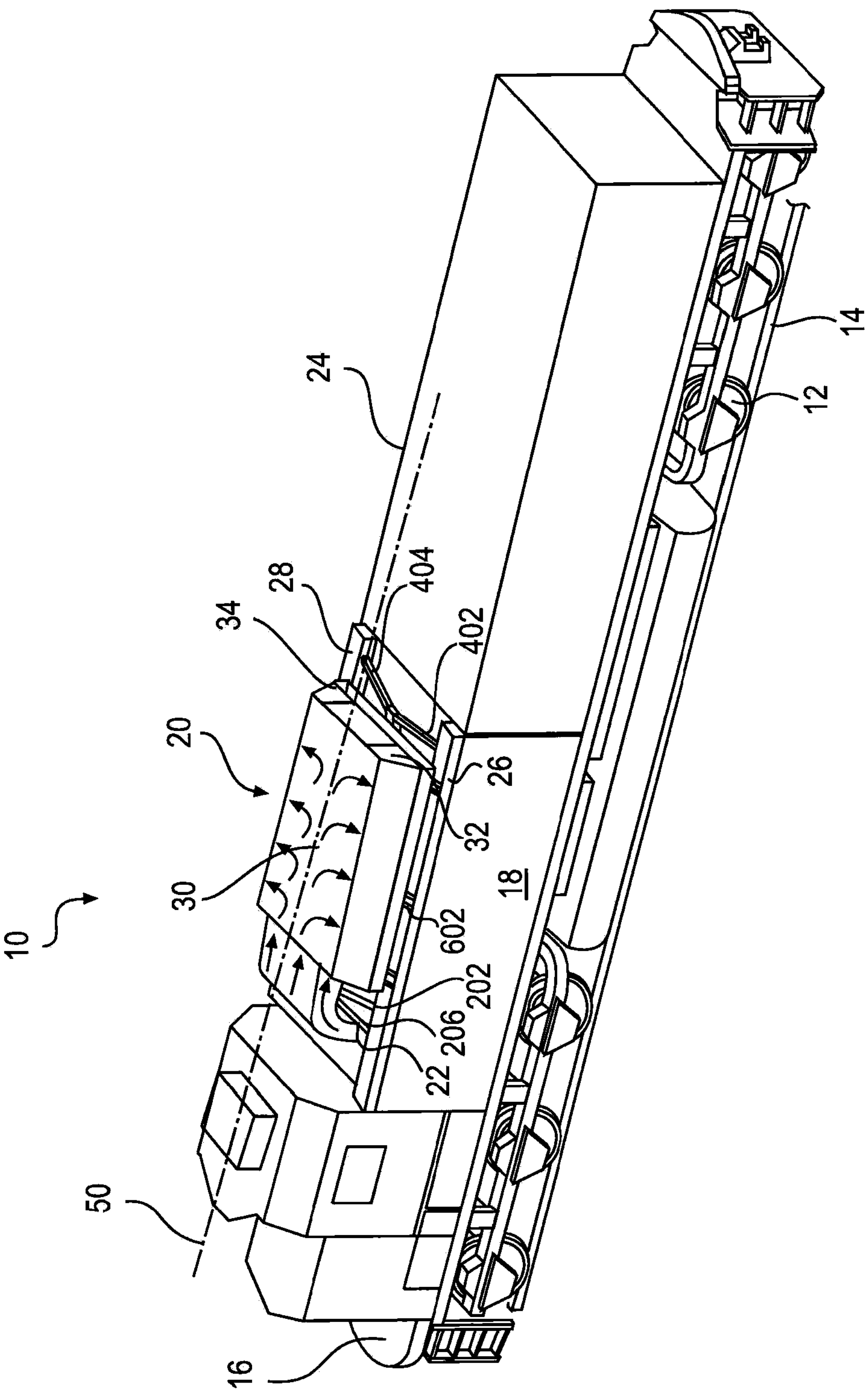


FIG. 1

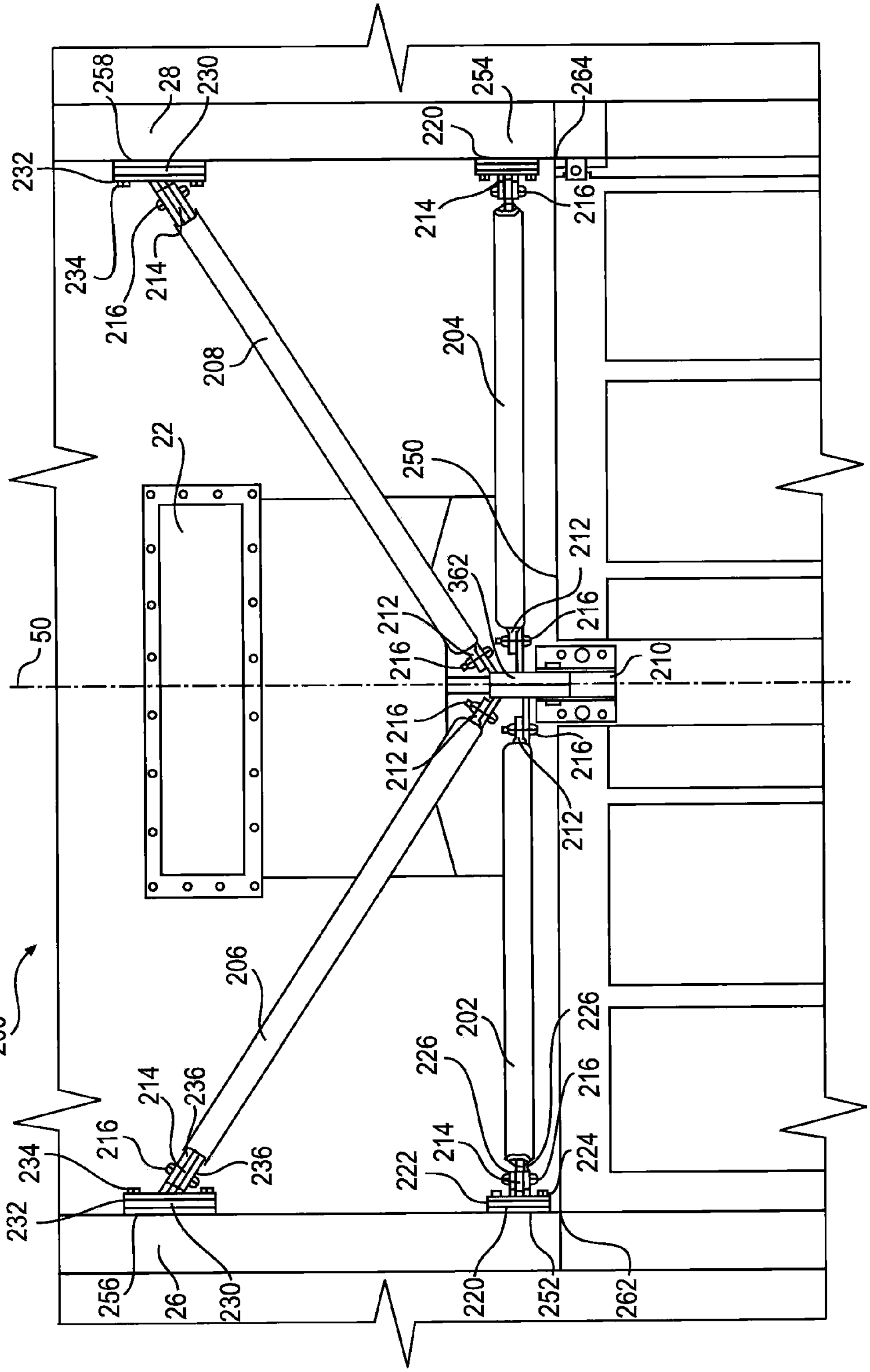


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FIG. 2

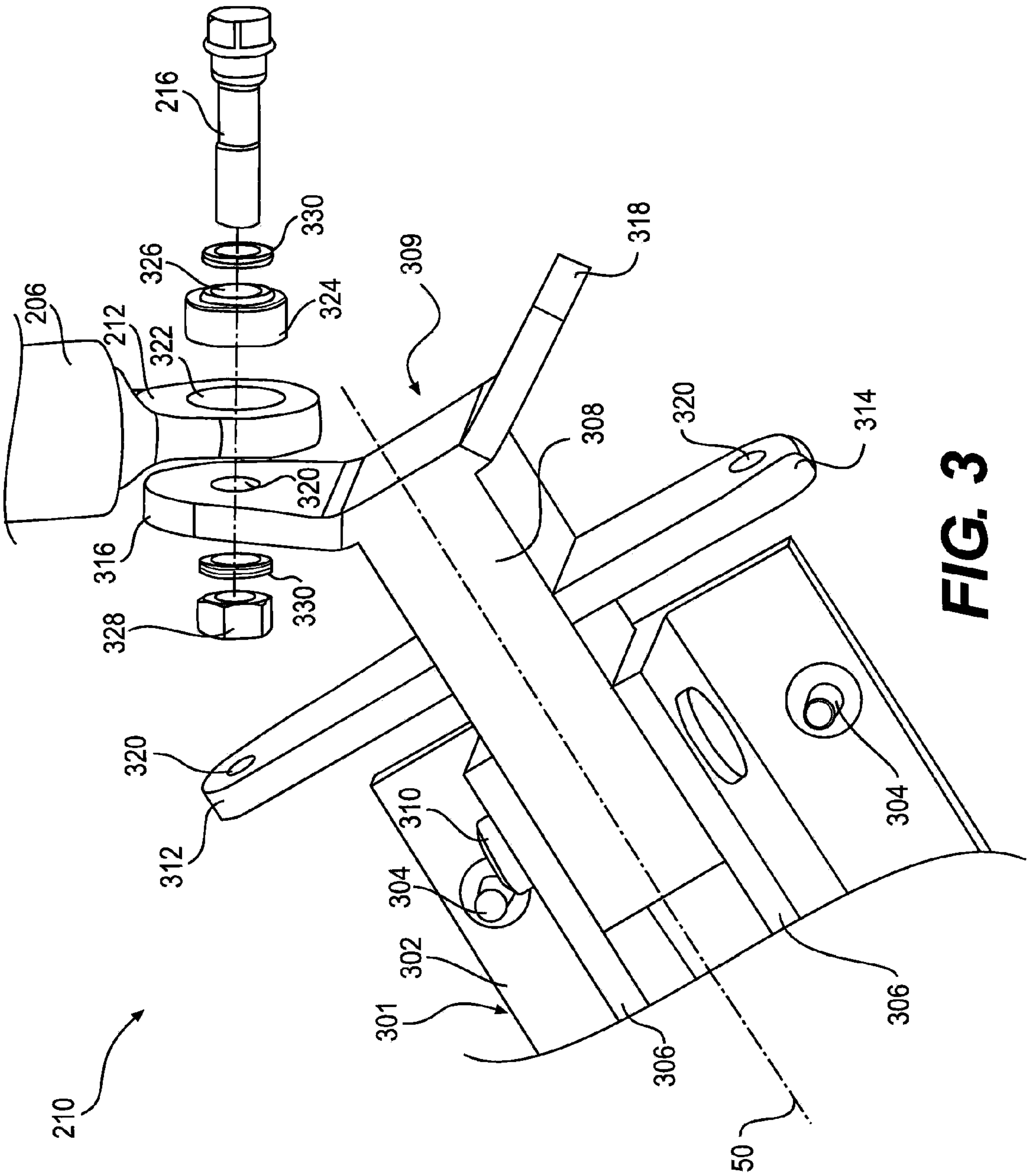
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FIG. 3

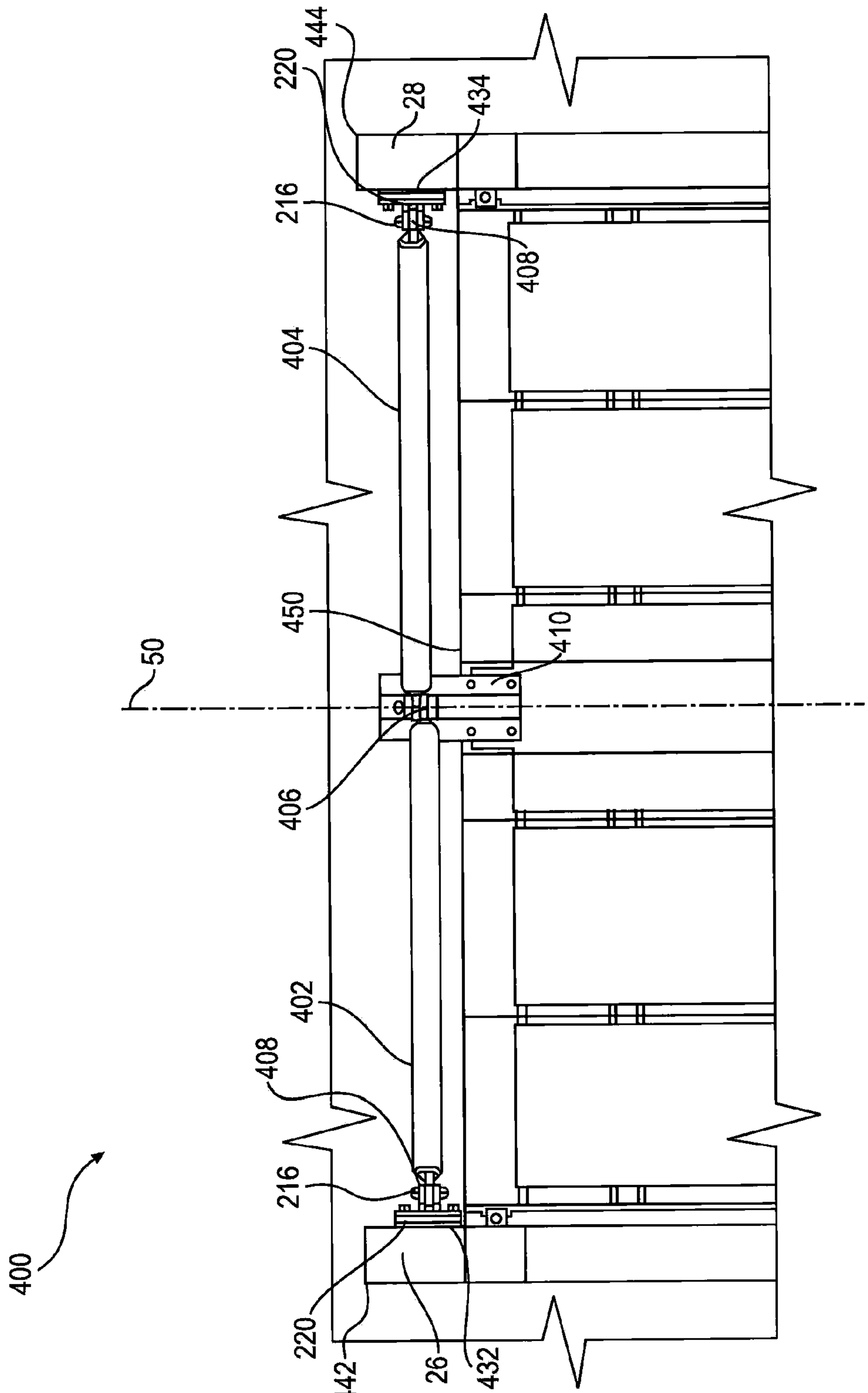
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FIG. 4

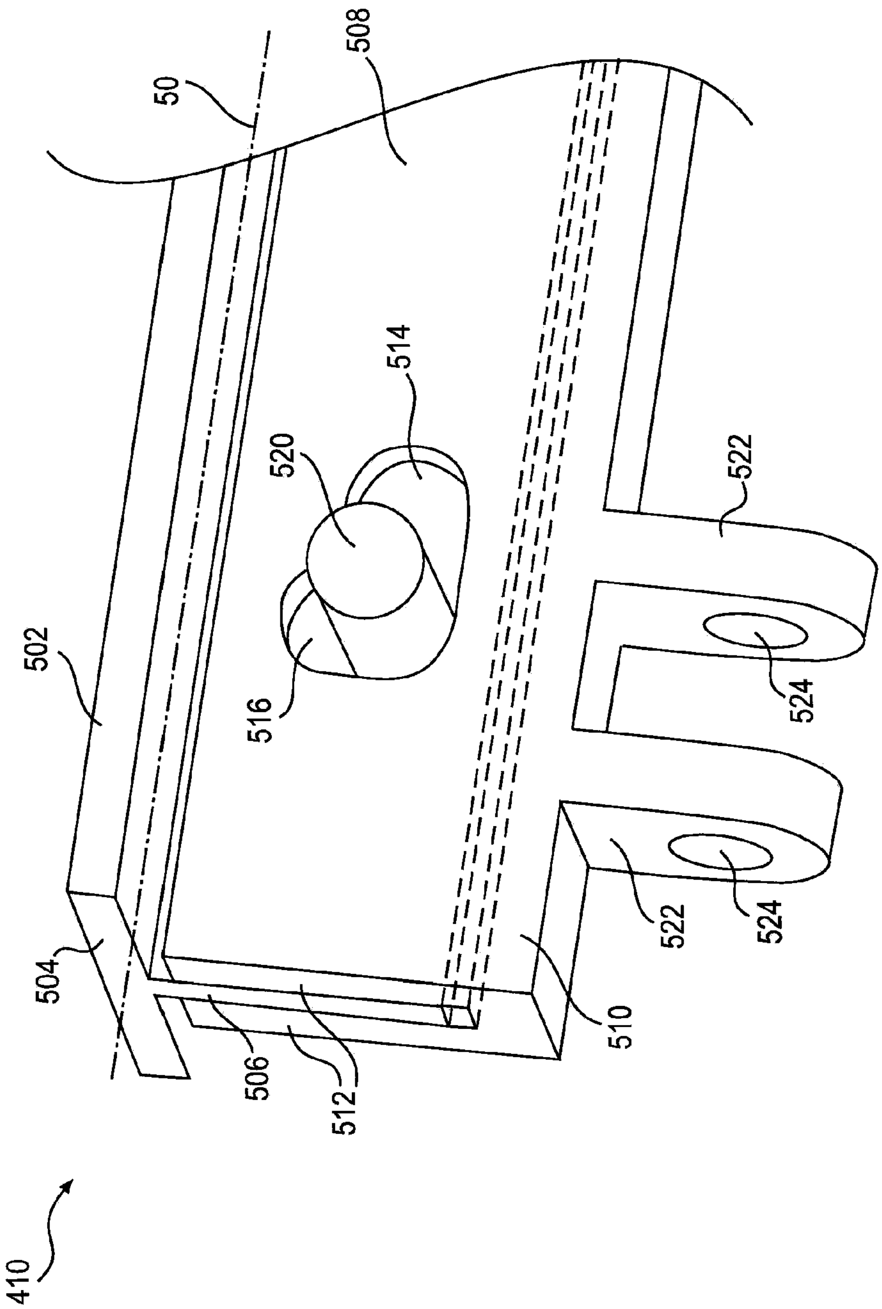

FIG. 5

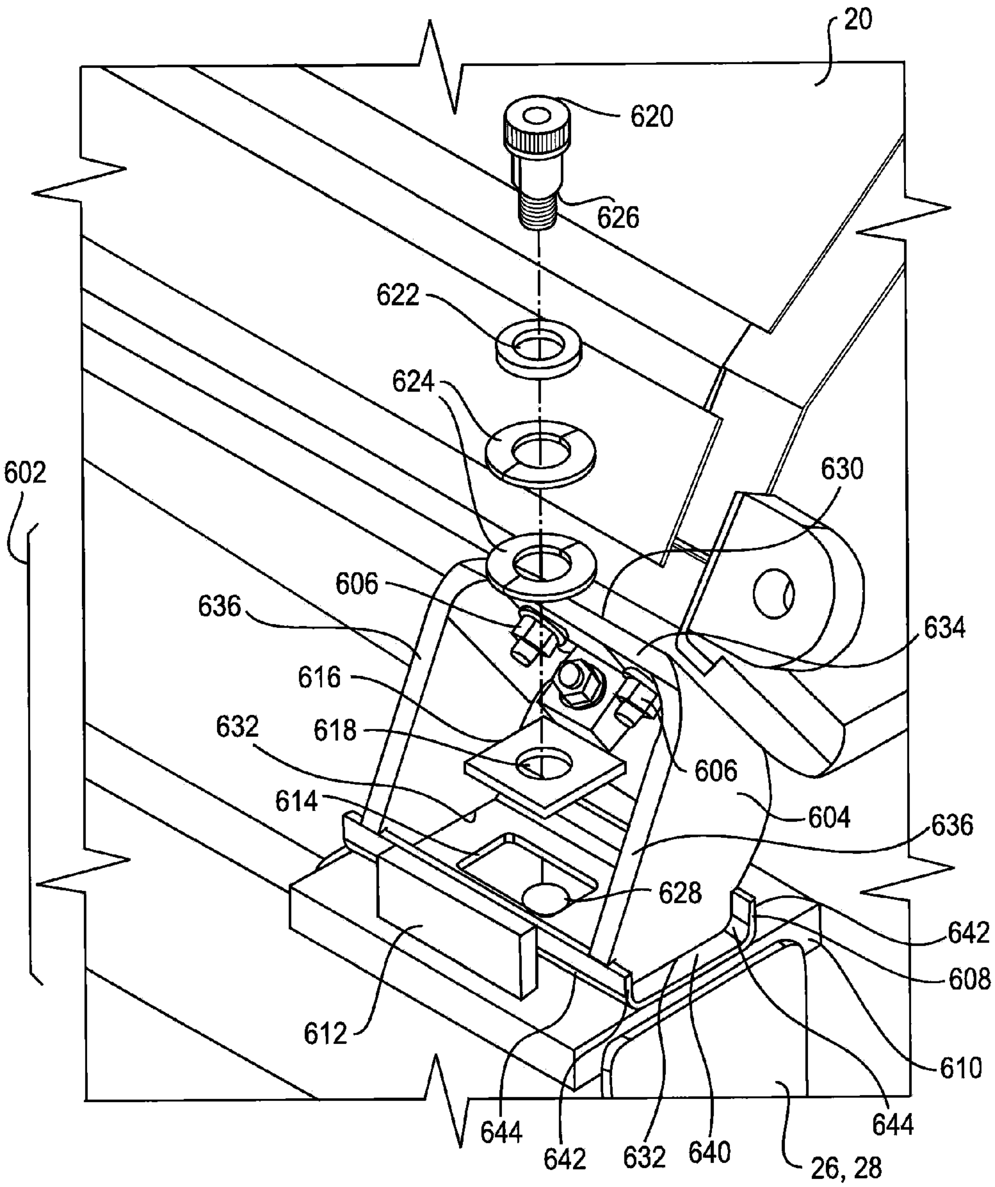
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FIG. 6

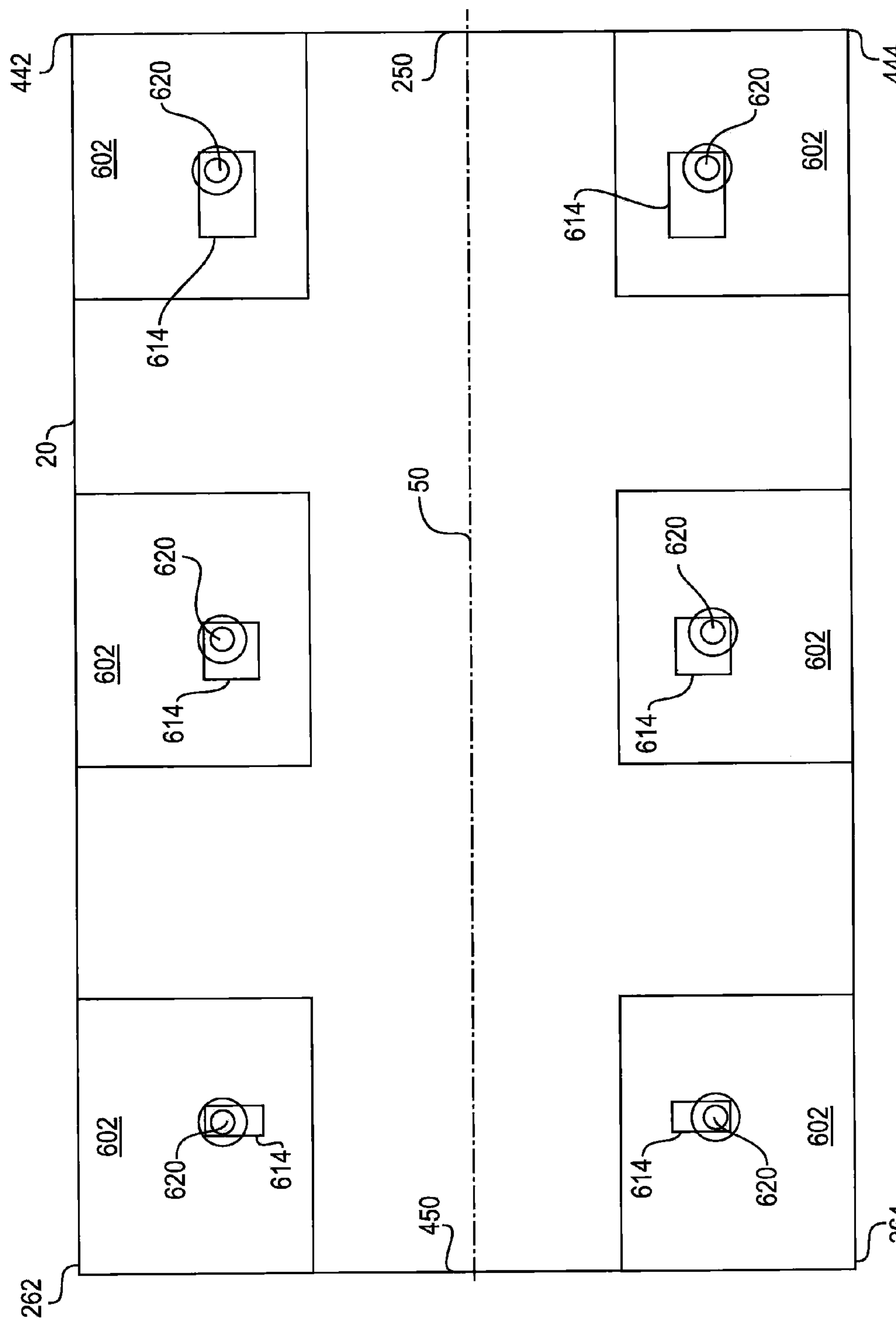

FIG. 7

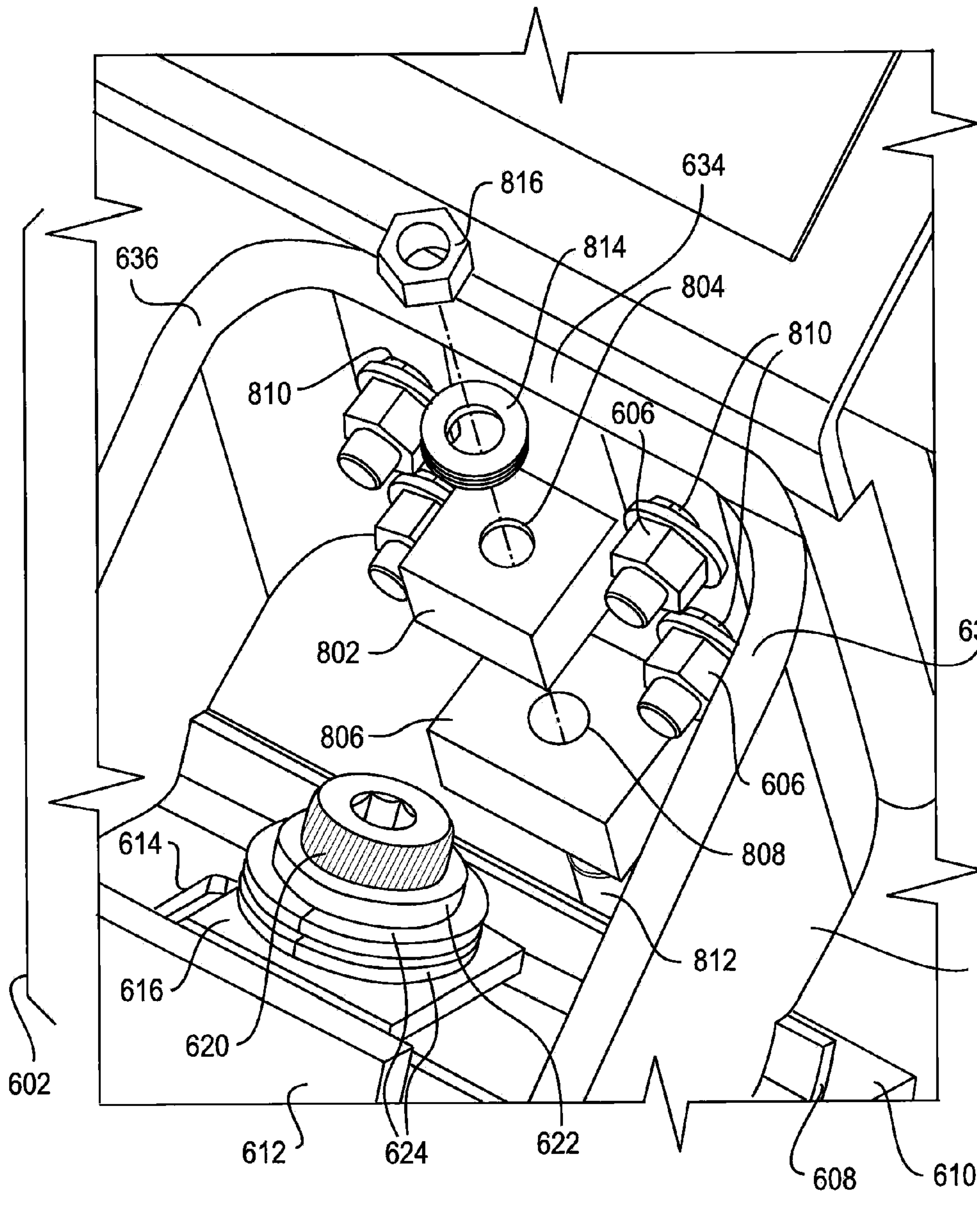
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FIG. 8

BRACKET FOR AN AFTER-TREATMENT COMPONENT

TECHNICAL FIELD

The present disclosure relates generally to a bracket and, more particularly, to a bracket for an after-treatment component.

BACKGROUND

Internal combustion engines generate exhaust as a by-product of fuel combustion within the engines. Engine exhaust contains, among other things, unburnt fuel, particulate matter such as soot, and harmful gases such as carbon monoxide or nitrous oxide. To comply with regulatory emissions control requirements, engine exhaust must be cleaned before it is discharged into the atmosphere.

Engines typically include after-treatment devices that remove or reduce harmful gases and particulate matter in the exhaust. The after-treatment devices may be located in an after-treatment system mounted either on the engine or on a frame of a machine associated with the engine. An on-engine after-treatment system must meet a large number of criteria designed to ensure longevity and ease of use. For example, an on-engine after-treatment system should be capable of being assembled in a relatively limited amount of space. Moreover, the components used for mounting the after-treatment system must be able to withstand loads generated because of sudden changes in velocity or temperature, while maintaining general alignment of an exhaust inlet of the after-treatment system with an exhaust outlet from the engine.

An exemplary after-treatment system is disclosed in World Intellectual Property Organization International Publication No. WO 2011/087819 of Kiran et al. that was published on Jul. 21, 2011 ("the '819 publication"). Specifically, the '819 publication discloses a mounting system for an exhaust after-treatment system that is isolated from shock and vibration loads. The disclosed system includes isolators that attach the exhaust after-treatment system to a support structure. The '819 publication discloses two different types of isolators, namely stiff isolators and soft isolators. The stiff isolators are used at one end of the mounting system to limit movement of the after-treatment system at that end. The soft isolators are used in other locations to allow for thermal expansion.

Although the system of the '819 publication may be adequate for some situations, it may also be problematic. In particular, the stiff isolators may not sufficiently constrain movement of the exhaust inlet of the after-treatment system during operation of the machine. As a result, the exhaust inlet of the after-treatment system and the exhaust outlet of the engine may become misaligned or may induce stresses on the coupling between them. Further, the soft isolators may limit an amount of thermal expansion of the after-treatment system, thereby inducing stress in the after-treatment devices.

The bracket of the present disclosure solves one or more of the problems set forth above and/or other problems in the art.

SUMMARY

In one aspect, the present disclosure is directed to a bracket for connecting an after-treatment component to a frame. The bracket may include a clevis connectable to the after-treatment component. The bracket may also include a front link coupler. The front link coupler may include a tang connected to the clevis. The front link coupler may also include a first flange extending outward from the tang and a second flange extending outward from the tang opposite the first flange. In addition, the front link coupler may include a third flange spaced apart from the first flange and extending outward from the tang and a fourth flange spaced apart from the second flange and extending outward from the tang opposite the third flange. The first, second, third, and fourth flanges may be connectable to the frame.

In another aspect, the present disclosure is directed to a bracket for connecting an after-treatment component to a frame. The bracket may include a clevis connectable to the after-treatment component. The bracket may also include a front link coupler. The front link coupler may include a tang connected to the clevis. The front link coupler may also include a first flange extending orthogonally outward from the tang and a second flange extending orthogonally outward from the tang opposite the first flange. In addition, the front link coupler may include a third flange spaced apart from the first flange and extending outward from the tang at an angle of about 15 to 40° relative to a longitudinal axis of the after-treatment component. The front link coupler may also include a fourth flange spaced apart from the second flange and extending outward from the tang at an angle of about 15 to 40° relative to the longitudinal axis. The first, second, third, and fourth flanges may be connectable to the frame.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a pictorial illustration of an exemplary disclosed after-treatment component mounted to a machine; and

FIGS. **2-8** are pictorial illustrations of an exemplary disclosed mounting system for the after-treatment component of FIG. **1**.

DETAILED DESCRIPTION

FIG. **1** illustrates a machine **10** with an exemplary embodiment of an after-treatment component **20** mounted on machine **10**. Machine **10** may be a mobile machine that performs some type of operation associated with an industry such as transportation, marine, mining, construction, farming, power generation, or any other industry known in the art. For example, machine **10** may be a locomotive designed to pull rolling stock. Machine **10** may have a plurality of wheels **12** configured to engage a track **14**, a base platform **16** supported by wheels **12**, and an engine **18** mounted to base platform **16** and configured to drive wheels **12**. In the exemplary embodiment shown in FIG. **1**, engine **18** may be lengthwise aligned on base platform **16** along a travel direction of machine **10**. Although only one engine **18** is shown in FIG. **1**, it is contemplated that any number of additional engines may be included within machine **10** and operated to produce power that may be transferred to one or more traction motors (not shown) used to drive wheels **12**.

Engine **18** may be fluidly connected to after-treatment component **20**, which may include multiple fluid paths that direct exhaust from engine **18** to the atmosphere. For example, exhaust from engine **18** may enter after-treatment component **20** via an inlet **22**. After-treatment component **20** may be mounted on frame **24** of machine **10** by way of one or more rails **26**, **28**. Rails **26**, **28** may be attached to an upper portion of frame **24** using welds, rivets, fasteners, or by any other means of attachment known in the art.

After-treatment component **20** may have a center plenum **30**, which may separate into two outboard plenums **32** and **34**, which discharge exhaust to the atmosphere. Any number and type of exhaust treatment components may be located between center plenum **30** and outboard plenums **32** and **34**.

After-treatment component **20** may undergo thermal expansion as a temperature of after-treatment component **20** increases from an ambient temperature to an operating temperature. In particular, dimensions of after-treatment component **20** may increase laterally in a plane generally orthogonal to a longitudinal axis **50** of after-treatment component **20**. A length of after-treatment component **20** may also increase along longitudinal axis **50** because of thermal expansion. In one exemplary embodiment, the temperature of after-treatment component **20** may increase from about 650° F. during normal operation of machine **10** to about 1200° F. during a regeneration event. As a result, in one exemplary embodiment, after-treatment component **20** may laterally expand by about 0.25 to 0.38 inches and longitudinally expand by about 0.75 to 1.00 inches.

After-treatment component **20** may be attached to rails **26**, **28** via links **202**, **206**, **402**, and **404**. After-treatment component **20** may also be supported on rails **26** and **28** via mounting feet **602**. Although FIG. **1** illustrates four links **202**, **206**, **402**, and **404**, it is contemplated that any number links may be used to connect after-treatment component **20** to rails **26**, **28**.

FIG. **2** shows a bottom view of a front attach arrangement **200** associated with after-treatment component **20**. Specifically, FIG. **2** shows a view from below after-treatment component **20** looking upward at a front end **250** of after-treatment component **20**. Front attach arrangement **200** may include a front center bracket **210** connected to front end **250** of after-treatment component **20**. Front center bracket **210** may be fixedly attached to after-treatment component **20** using fasteners, rivets, welds, or by any other appropriate means of attachment known in the art. Front links **202**, **204**, **206**, and **208** may connect front center bracket **210** to rails **26**, **28**. Front links **202**, **204**, **206**, and **208** each may have a first end **212** and a second end **214**. First ends **212** of front links **202**, **204**, **206**, and **208** may be pivotally connected to front center bracket **210** via one or more fasteners **216**. Second ends **214** of first and second front links **202** and **204** may be pivotally connected to first and second rails **26** and **28**, respectively, via a pair of orthogonal rail brackets **220**. Second ends **214** of third and fourth front links **206** and **208** may be pivotally connected to first and second rails **26** and **28**, respectively, via a pair of angled rail brackets **230**. First and second front links **202** and **204** may be disposed generally orthogonal to longitudinal axis **50**. Third and fourth links **206** and **208** may be disposed at an angle with respect to longitudinal axis **50**. In one exemplary embodiment, an angle between third and fourth links **206**, **208** and longitudinal axis **50** may range from about 30° to 60°.

Orthogonal rail brackets **220** may be fixedly attached to first and second rails **26**, **28** using fasteners, rivets, welds, or by any other appropriate means of attachment known in the art. Second end **214** of first front link **202** may be pivotally connected via one or more fasteners **216** to orthogonal rail bracket **220** at a first front location **252** adjacent to a first corner **262** of after-treatment component **20**. Likewise, second end **214** of second front link **204** may be pivotally connected via one or more fasteners **216** to orthogonal rail bracket **220** at a second front location **254** opposite first front location **252** and adjacent to a second corner **264** of after-treatment component **20**.

Orthogonal rail bracket **220** may include a generally flat base **222**. Base **222** may be fixedly attached to first or second rails **26**, **28** using one or more fasteners **224**. Alternatively, base **222** may be fixedly attached to first or second rails **26**, **28** using rivets, welds, or by any other appropriate means of attachment known in the art. Orthogonal rail bracket **220** may further include ears or tabs **226** extending generally orthogonal to base **222** away from rails **26**, **28**. Tabs **226** may be welded to base **222** or otherwise integrally formed with base **222**. Tabs **226** may be disposed generally parallel to each other and generally orthogonal to longitudinal axis **50**. Tabs **226** may be spaced apart to receive second ends **214** of first or second front links **202**, **204** therebetween.

Angled rail brackets **230** may be fixedly attached to first and second rails **26**, **28** using fasteners, rivets, welds, or by any other appropriate means of attachment known in the art. Second end **214** of third front link **206** may be pivotally connected via fastener **216** to angled rail bracket **230** at third front location **256** spaced apart from and on the same side as first front location **252**. Second end **214** of fourth front link **208** may be pivotally connected via fastener **216** to angled rail bracket **230** at fourth front location **258** opposite third front location **256**.

Angled rail bracket **230** may include a generally flat base **232**. Base **232** may be fixedly attached to first or second rails **26**, **28** using fasteners **234**. Alternatively, base **232** may be fixedly attached to first or second rails **26**, **28** using rivets, by welding or brazing, or by any other appropriate means of attachment known in the art. Angled rail bracket **230** may further include angled ears or tabs **236** extending outward at an angle from base **232**. In one exemplary embodiment, an angle between angled ears or tabs **236** and base **232** may range from about 30° to 60°. Angled ears **236** may be integrally formed with base **232**. Angled ears **236** may be disposed generally parallel to each other and generally at an angle relative to longitudinal axis **50**. In one exemplary embodiment, an angle between angled ears or tabs **236** and longitudinal axis **50** may range from about 30° to 60°. Angled ears **236** may be spaced apart to receive second ends **214** of third or fourth front links **206**, **208** therebetween.

Front center bracket **210** may be located at a predetermined distance above rails **26**, **28**. As a result, first and second front links **202** and **204** may form a V-shaped truss in a vertical plane. Likewise, third and fourth front links **206** and **208** may also form a V-shaped truss in a plane angled with respect to the vertical plane. Front links **202**, **204**, **206**, and **208** may help reduce or eliminate movement of front center bracket **210** relative to frame **24**. As a result, front links **202**, **204**, **206**, and **208** may help ensure that inlet **22** of after-treatment component **20** remains aligned with an exhaust outlet of engine **18**.

FIG. **3** illustrates one exemplary embodiment of front center bracket **210**. Front center bracket **210** may include a clevis **301** and a front link coupler **309**. As used in this disclosure, clevis refers to a substantially U-shaped structural member. For example, as shown in FIG. **3**, clevis **301** may have a generally flat clevis base **302** that may be fixedly attached to after-treatment component **20** using one or more fasteners **304**. Alternatively, clevis base **302** may be fixedly attached to after-treatment component **20** using rivets, by welding or brazing, or by any other appropriate means of attachment known in the art. As further illustrated in FIG. **3**, Clevis **301** may have a pair of legs **306** extending outward generally orthogonal to clevis base **302**. Legs **306** may be formed integral with clevis base **302**. Legs **306** may be disposed parallel to longitudinal axis **50** and may be spaced apart to receive front link coupler **309** therebetween.

Front link coupler **309** may also include a tang **308**. As used in this disclosure, tang refers to a bar shaped member that may be attached to a clevis. For example, as shown in FIG. **3**, tang **308** may be pivotally connected to legs **306** using one or more fasteners **310** and may be slidably disposed between legs **306** of clevis **301**. In one exemplary embodiment fastener **310** may be a shear pin. During assembly of after-treatment component **20** on frame **24**, tang **308** may slide between and pivot relative to legs **306** to help ensure that after-treatment component **20** can be desirably positioned relative to frame **24**. Front link coupler **309** may be designed to withstand thrust loads exerted along longitudinal axis **50** during operation of machine **10**, thereby helping to reduce or eliminate movement of front center bracket **210** along longitudinal axis **50** in response to the thrust loads. In one exemplary embodiment, tang **308** may be designed to withstand thrust loads ranging from about 3 g to 5 g.

As shown in FIG. **3**, a plurality of flanges **312**, **314**, **316**, and **318** may be attached to tang **308**. Flanges **312**, **314**, **316**, and **318** may be integrally formed with tang **308**. Alternatively, flanges **312**, **314**, **316**, and **318** may be welded or attached to tang **308** by any other appropriate means of attachment known in the art. Flanges **312**, **314**, **316**, and **318** may have a bore **320**. Flanges **312** and **314** may extend outward on either side of tang **308** and may be disposed generally orthogonal to tang **308** and to longitudinal axis **50**. Flanges **316** and **318** may also extend outward from tang **308** on either side. Flanges **316** and **318** may be disposed at an angle relative to longitudinal axis **50**. In one exemplary embodiment, flanges **316**, **318** may be disposed at an angle of about 15° to 40° relative to longitudinal axis **50**. A relatively smaller angle may allow third and fourth front links **206** and **208** to form a relatively acute angled V-shaped truss, which may help prevent movement of front center bracket **210** along longitudinal axis **50**. In some exemplary embodiments, a larger angle may be necessary to assemble after-treatment component **20** in the limited space available on machine **10**.

As shown in FIG. **3**, first end **212** of third front link **206** may be generally flat and may have a bore **322**. A bearing **324** may be disposed within bore **322**. In one exemplary embodiment, bearing **324** may be a spherical bearing, which may have a bore **326**. Fastener **216** may pass through bore **326** in bearing **324** and bore **322** in flange **316** to engage a nut **328**. One or more washers **330** may be interposed between fastener **216** and bearing **324** and also between flange **316** and nut **328**. First ends **212** and second ends **214** of all front links **202**, **204**, **206**, and **208** may have a structure similar to first end **212** of third front link **206** described above.

FIG. **4** shows a bottom view of a rear attach arrangement **400** of after-treatment component **20**. Specifically, FIG. **4** illustrates a view from below after-treatment component **20** looking upward at a rear end **450** of after-treatment component **20**. Rear attach arrangement **400** may include a rear center bracket **410** connected to rear end **450** via one or more fasteners, rivets, welds, or by any other means of attachment known in the art. Rear center bracket **410** may be connected to rails **26** and **28** via first and second rear links **402** and **404**, respectively. First and second rear links **402** and **404** may each have a first end **406** and a second end **408**. First ends **406** and second ends **408** of first and second rear links **402** and **404**, respectively, may have a structure similar to first end **212** of third front link **206** described above. First ends **406** of first and second rear links **402** and **404** may be connected to rear center bracket **410** via one or more fasteners **216**. Second ends **408** of first and second rear links **402**,**404** may be connected to first and second rails **26**, **28**, respectively, via orthogonal rail brackets **220**. Orthogonal rail brackets **220** may be fixedly attached to first and second rails **26**, **28** using fasteners, rivets, welds, or by any other appropriate means of attachment known in the art. Second end **408** of first rear link **402** may be pivotally connected via one or more fasteners **216** to orthogonal rail bracket **220** at a first rear location **432** adjacent to third corner **442** of after-treatment component **20**. Likewise, second end **408** of second rear link **404** may be pivotally connected via one or more fasteners **216** to orthogonal rail bracket **220** at a second rear location **434**, opposite first rear location **432** and adjacent to a fourth corner **444** of after-treatment component **20**.

Rear center bracket **410** may be located at a predetermined distance above rails **26**, **28**. As a result, first and second rear links **402** and **404** may form a V-shaped truss in a vertical plane. First and second rear links **402**, **404** may be oriented generally orthogonal to longitudinal axis **50** of after-treatment component **20**. Further, first rear link **402** may be disposed so as to oppose movement of first end **406** of second rear link **404** in a plane orthogonal to longitudinal axis **50**. Likewise, second rear link **404** may be disposed to oppose movement of first end **406** of first rear link **402** in a plane orthogonal to longitudinal axis **50**. As a result, first and second rear links **402**, **404** may help reduce or eliminate movement of rear end **450** in a plane orthogonal to longitudinal axis **50** and may also thereby help reduce or eliminate sideways movement of after-treatment component **20** relative to frame **24**. First and second links **402**, **404** may not constrain after-treatment component **20** from movement along longitudinal axis **50**.

FIG. **5** illustrates an exemplary disclosed rear center bracket **410**. Rear center bracket **410** may include a rail **502** having a base **504** and a protrusion **506** extending outward from and orthogonal to base **504**. Protrusion **506** may be integrally formed with base **504**. Rail **502** may be fixedly attached to after-treatment component **20** using fasteners, rivets, welds, or by any other appropriate means of attachment known in the art. Rail **502** may be lengthwise aligned with after-treatment component **20**.

Rear center bracket **410** may also include rear link coupler **508** having a link coupler base **510** and legs **512** extending outward from and orthogonal to link coupler base **510**. Legs **512** may be integrally formed with link coupler base **510**. Legs **512** may be spaced apart to receive protrusion **506** of rail **502** therebetween.

Legs **512** may have a generally horizontal slot **514** and a generally vertical slot **516**, which may at least partially overlap each other. A guide post **520** may extend outward from and orthogonal to protrusion **506** and be receivable within slots **514**, **516**. Guide post **520** may be attached to protrusion **506** and may extend orthogonally away from protrusion **506**. Guide post **520** may be attached to protrusion **506** by welding, brazing, a threaded joint, press fit, or any other appropriate method of attachment known in the art. In one exemplary embodiment, guide post **520** may be cylindrical. It is contemplated, however, that guide post **520** may have a square, triangular, polygonal or any other appropriate cross-sectional shape known in the art.

Rail **502** may be slidably movable relative to rear link coupler **508**. For example, when after-treatment component **20** experiences thermal expansion, rail **502** may slide relative to rear link coupler **508**. Movement of rail **502** may be guided and limited in two directions by protrusion **506**, guide post **520**, and horizontal and vertical slots **514**, **516**.

Rear link coupler **508** may also have ears or tabs **522**, which extend outward from and orthogonal to link coupler base **510** in a direction opposite legs **512**. Ears **522** may be integrally formed with link coupler base **510**. Alternatively, ears **522** may be attached to link coupler base **510** using fasteners, rivets, welds, or by any other appropriate means of attachment known in the art. Ears **522** may be disposed orthogonal to longitudinal axis **50** of after-treatment component **20** and orthogonal to legs **512**. Ears **522** may have bores **524** with an axis generally parallel to longitudinal axis **50**. Ears **522** may be spaced apart to receive first ends **406** of rear links **402**, **404** therebetween. Fastener **216** may pass through bores **524** to pivotally connect first ends **406** of rear links **402**, **404** to rear link coupler **508**. Fastener **216** may also pass through bore **326** in bearing **324** and bore **322** in flange **316** to engage a nut **328**. One or more washers **330** may be interposed between fastener **216** and bearing **324** and also between flange **316** and nut **328**.

Front and rear links **202**, **204**, **206**, **208**, **402**, and **404** may be tubular members. It is contemplated, however, that front and rear links **202**, **204**, **206**, **208**, **402**, and **404** may have any other shape or cross-section known in the art. In one exemplary embodiment, front and rear links **202**, **204**, **206**, **208**, **402**, and **404** may have a hollow circular cross-section. An inner diameter and an outer diameter of the hollow circular cross-section may be selected so that compressive stresses induced during operation of machine **10** within each link remain below buckling stresses. The inner and outer diameters of the hollow circular cross-section may also be selected such that front and rear links **202**, **204**, **206**, **208**, **402**, and **404** may withstand buff, drag, and lateral loads, generated during operation of machine **10**, without significant lengthwise deformation. In one exemplary embodiment, front and rear links **202**, **204**, **206**, **208**, **402**, and **404** may be designed to withstand buff loads of up to about 5 g and lateral loads of up to about 1.5 g. Rear links **402** and **404** may be designed to withstand lateral loads of 1.5 g. In another exemplary embodiment, front and rear links **202**, **204**, **206**, **208**, **402**, and **404** may be made out of mild steel, because mild steel has the desired structural properties, can be easily welded, and is also relatively inexpensive.

FIG. **6** illustrates an exemplary disclosed embodiment of a mounting foot **602**. Mounting foot **602** may have a mounting bracket **604** connected at a first end **630** to after-treatment component **20** via fasteners **606**. Mounting bracket **604** may be connected at a second end **632** opposite first end **630** to a slider **608**, which may be slidably connected to a pad **610**. Pad **610** may be fixedly connected to an upper portion of first or second rails **26**, **28** using fasteners, rivets, welds, or any other attachment means known in the art. A stop **612** may be connected to an end of pad **610** using fasteners, rivets, welds, or any other attachment means known in the art. Stop **612** may extend orthogonal to pad **610** and away from frame **24**. Stop **612** may be lengthwise aligned parallel to longitudinal axis **50** of after-treatment component **20**. Stop **612** may limit an amount by which slider **608** may traverse pad **610**. Mounting bracket **604** may be connected to pad **610** in a variety of ways. For example, mounting bracket **604** may be loosely connected to and constrained from significant movement relative to pad **610** using fasteners, rivets, welds, or any other appropriate method known in the art.

Mounting bracket **604** may include a mounting bracket base **634** and a pair of legs **636** extending orthogonally from mounting bracket base **634** towards slider **608**. Distal ends **632** of legs **636** may be connected to slider **608**. Mounting bracket base **634** may be disposed at an angle with respect to slider **608** to facilitate mating of mounting bracket with after-treatment component **20**. In one exemplary embodiment, the angle between mounting bracket base **634** and slider **608** may be about 30° to 60°. Legs **636** may also be disposed at an angle with respect to slider **608**. Disposing legs **636** at an angle may help reduce the frictional load between slider **608** and pad **610** because only a component of the weight exerted by after-treatment component **20** on mounting bracket **604** may contribute to the frictional load. In one exemplary embodiment, an angle between legs **636** and slider **608** may be about 30° to 60°. Legs **636** of mounting bracket **604** may be connected to slider **608** using fasteners, rivets, welds, or any other appropriate method known in the art.

As also shown in FIG. **6**, slider **608** may include a generally flat slider base **640**. Curved flanges **642** may extend orthogonally from slider base **640** away from pad **610**. Curved flanges **642** may be integrally formed with slider base **640** or may be joined to slider base **640** using welds or any other appropriate method known in the art. Curved surfaces **644**, formed at the joint of curved flanges **642** and slider base **640**, may facilitate slidability of slider **608** on pad **610**. For example, curved surfaces **644** may help slider base **640** slide on pad **610** when pad **610** has a rough or uneven surface or when impurities or dust particles are present on pad **610**.

Slider base **640** may have a slot **614** formed therein. Slot **614** may be rectangular, square, circular, or may have any other appropriate shape known in the art. Mounting foot **602** may have plate **616**, which may have a size larger than slot **614** so as to at least partially cover slot **614**. Plate **616** may have a bore **618** and may be connected to pad **610** via fastener **620**, which passes through washers **622** and **624**, and bore **618** in plate **616**. Threads on an end of fastener **620** may mate with corresponding threads in opening **628** in rail **26** or **28**. Fastener **620** may be tightened so that mounting foot **602** is retained against first and second rails **26**, **28** but allowed to slide somewhat along pad **610**. Slider **608** and pad **610** may be made out of wear-resistant material to help prevent excessive wear on these parts during operation of machine **10**. The materials used to make slider **608** and pad **610** may also be selected so as to create an anti-galling material pair. For example, slider **608** may be made out of Nitronic 60 and pad **610** may be made of mild steel, or vice-versa. In another exemplary embodiment, slider **608** and pad **610** may both be made out of Nitronic 60.

Fastener **620** may be a shoulder screw designed to maintain a predetermined gap between shoulder **626** and plate **616**. A predetermined number of washers **622** may be interposed between shoulder **626** and plate **616** to help ensure that a desired amount of load is applied by fastener **620** on plate **616**. The number of washers **622** selected may help ensure that the load applied by fastener **620** on plate **616** is not too high to prevent slider **608** from sliding on pad **610** due to thermal expansion of after-treatment component **20** and not too low such that slider **608** can slide on pad **610** under the influence of lateral forces. In one exemplary embodiment, the predetermined number of washers **622** may range from about 2 to 5 and the corresponding load applied by fastener **620** on plate **616** may range from about 3800 to 10000 lbs.

FIG. **7** is a pictorial illustration of mounting feet **602** of after-treatment component **20**. As shown in FIG. **7**, after-treatment component may have mounting feet **602** located near first and second corners **262**, **264** of after-treatment component **20**, near third and fourth corners **442**, **444** of after-treatment component **20**, and at locations between the first and third corners **262**, **442** and between the second and fourth corners **264**, **444**. Mounting feet **602** may be located to appropriately distribute a weight of after-treatment component **20** on rails **26**, **28**. In one exemplary embodiment, mounting feet **602** may together carry about 5000-7000 lbs.

As further shown in FIG. **7**, slot **614** may be sized differently according to a location along after-treatment component **20**. For example, slots **614** on mounting feet **602** located adjacent to first and second corners **262**, **264** of after-treatment component **20** may be rectangular and may be configured to allow mounting feet **602** to slide only in a direction orthogonal to longitudinal axis **50**. For example, slots **602** located adjacent to first and second corners **262**, **264** may have a width only slightly larger than fastener **620**. Slots **614** in mounting feet **602** located at the midpoint of after-treatment component **20** may be larger and may allow mounting feet **602** to slide in both directions, parallel and orthogonal to longitudinal axis **50**. Likewise, slots **614** in mounting feet **602** located adjacent to third and fourth corners **442**, **444** of after-treatment component **20** may be the largest to allow mounting feet **602** to slide by a maximum amount in directions both parallel and orthogonal to longitudinal axis **50**. As a temperature of after-treatment component increases from an ambient to the operating temperature, larger dimensional change may occur nearer third and fourth corners **442**, **444** compared to near first and second corners **262**, **264** where movement of after-treatment component **20** may be constrained by front links **202**, **204**, **206**, and **208**, and by slots **614**.

FIG. **8** illustrates an exploded view of another portion of mounting foot **602**. As seen in FIG. **8**, mounting bracket **604** of mounting foot **602** may have a first ledge **802** with a first bore **804**. A second ledge **806** with a second bore **808** may be attached to after-treatment component **20**. Second ledge **806** may be spaced apart from and disposed parallel to first ledge **802**. Fasteners **606** may pass through elongated slots **810** in mounting bracket base **634**. Jack screw **812** may pass through first and second bores **804** and **808** in first and second ledges **802** and **806**, respectively, and may pass through washer **814** to mate with nut **816**. Turning jack screw **812** may alter the distance between first and second ledges **802**, **806**. Because mounting bracket base **634** is disposed at an angle relative to slider **608**, altering the distance between first and second ledges **802**, **806** may allow after-treatment component **20** to be raised or lowered with respect to frame **24** to help align fastener openings (not shown) in after-treatment component **20** with elongated slots **810** in mounting bracket base **634** and to level mounting brackets relative to a plane formed by rails **26** and **28**.

INDUSTRIAL APPLICABILITY

The disclosed mounting system may be used in any machine or power system application to secure an after-treatment component to the machine. In particular, the disclosed mounting system may be used to secure the after-treatment component when the after-treatment component may be subjected to buff loads, drag loads, lateral loads, and vibration loads. In addition, the disclosed mounting system may be used to secure an after-treatment component when the after-treatment component may be subject to thermal expansion caused by operation of the component. The mounting system may hold the after-treatment component in a desired position while still accommodating dimensional change caused by thermal expansion.

For example, the disclosed front links may help ensure that the center of the front end of the after-treatment component does not move either parallel to or orthogonal to the longitudinal axis of the after-treatment component. In this manner, the disclosed mounting system may help ensure that the inlet of the after-treatment component may remain substantially aligned with the exhaust outlet from an associated engine. The slots in the mounting feet near the front end of the after-treatment component may allow the mounting feet to slide orthogonal to the longitudinal axis of the after-treatment component while limiting the movement of the mounting feet parallel to the longitudinal axis. As a result dimensional changes induced by thermal expansion may be accommodated near the front end with most of the dimensional changes taking place nearer the rear end of the component.

The rear center bracket and the mounting feet nearer the rear end of the after-treatment system may allow the rear end of the after-treatment component to move along the longitudinal axis of the after-treatment component. In this manner, the disclosed mounting system, may allow thermal expansion to occur substantially unrestricted at the rear end thereby reducing or eliminating any additional thermally-induced stress. Further, the disclosed front and rear links may be designed so that they can absorb buff and lateral loads generated during operation of the machine. Specifically, the cross-sectional area of the front and rear links may be selected to ensure that the stresses generated in the front and rear links because of buff, and lateral loads do not exceed a buckling stress limit.

As discussed above with respect to FIG. **2**, front links **202**, **204**, **206**, and **208** may help ensure that front center bracket **210** is immovable either along longitudinal axis **50** or orthogonal to longitudinal axis **50**. For example, first and second front links **202** and **204** may be disposed orthogonal to longitudinal axis **50**, and attached to rails **26**, **28** and front center bracket **210** so that each front link **202**, **204** opposes any elongation or compression in the other front link. As such, front links **202** and **204** may form a V shaped truss having a very high resistance to deformations in a plane orthogonal to longitudinal axis **50** thereby helping to reduce or eliminate movement of front center bracket **210** in a plane orthogonal to longitudinal axis **50**.

Third and fourth front links **206** and **208** may be oriented at an angle relative to longitudinal axis **50**, and attached to rails **26**, **28** and front center bracket **210** so that each front link **206**, **208** opposes any elongation or compression in response to buff or drag loads. Front links **206**, **208** may also form a V-shaped truss, having a very high resistance to deformations parallel to longitudinal axis **50** thereby helping to reduce or eliminate movement of front center bracket **210** along longitudinal axis **50**.

Front center bracket **210** may help ensure that front end **250** of after-treatment component **20** remains substantially immovable during operation of machine **10**. For example, flanges **312**, **314** of front center bracket **210** may help orient first and second front links **202**, **204** to form a V-shaped truss in a plane orthogonal to rails **26**, **28**. As discussed above, the V-shaped truss formed by first and second front links **202**, **204** may reduce or eliminate movement of front center bracket **210** and front end **250** in a plane orthogonal to longitudinal axis **50**. Flanges **316**, **318** may similarly help orient third and fourth links **206**, **208** to form a V-shaped truss which may help reduce or eliminate movement of front center bracket **210** and front end **250** along longitudinal axis **50**. Thus, front center bracket **210** may cooperate with first, second, third, and fourth links **202**, **204**, **206**, and **208** to help ensure that inlet **22** of after-treatment component **20** remains substantially aligned with an exhaust outlet from engine **18**.

Mounting feet **602** located near front end **250** may anchor after-treatment component **20** to rails **26**, **28** and permit thermal growth of after-treatment component **20** in a lateral direction (orthogonal to longitudinal axis **50** in a plane parallel to one formed by raisl **26**, **28**). In addition, as discussed above with respect to FIG. **7**, slots **614** in mounting feet **602** located adjacent to first and second corners **242**, **244** of after-treatment component **20** may be sized and oriented to prevent mounting feet **602** from sliding parallel to longitudinal axis **50**. As a result, inlet **22** may remain in substantially the same position relative to an exhaust outlet of engine **18**.

Further, as discussed above with respect to FIG. **2**, rear links **402** and **404** may be disposed orthogonal to longitudinal axis **50**, and attached to rails **26**, **28** and rear link coupler **508** so that each of rear links **402**, **404** opposes any elongation or compression in the other rear link. As such, rear links **402** and

404 may form a V shaped truss having a very high resistance to deformations in a plane orthogonal to longitudinal axis **50** thereby helping to reduce or eliminate movement of rear link coupler **508** and rear center bracket **410** in a plane orthogonal to longitudinal axis **50**.

Protrusion **506** of rail **502** may slide between legs **512** of rear link coupler **508**, thereby allowing rear end **450** of after-treatment component **20** to move as a result of thermal expansion. In addition, as discussed above with respect to FIG. **7**, slots **614** in mounting feet **602** located adjacent to third and fourth corners **442**, **444** of after-treatment component **20** may be sized and oriented to permit mounting feet **602** to slide orthogonal to and parallel to longitudinal axis **50** because of thermal expansion. In this manner, rear links **402** and **404**, and mounting feet **602** may permit after-treatment component **20** to expand during operation, thereby preventing generation of thermally induced stresses in after-treatment component **20**.

It will be apparent to those skilled in the art that various modifications and variations can be made to the disclosed bracket without departing from the scope of the disclosure. Other embodiments of the bracket will be apparent to those skilled in the art from consideration of the specification and practice of the mounting system disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope of the disclosure being indicated by the following claims and their equivalents.

What is claimed is:

1. A bracket for connecting an after-treatment component to a frame, comprising:
- a clevis, including:
  - a generally flat clevis base connectable to the after-treatment component;
  - a pair of legs extending outward from and orthogonal to the clevis base, the pair of legs being spaced apart from each other; and
- a front link coupler including:
  - a tang connected to the clevis, the tang being disposed between the pair of legs of the clevis;
  - a first flange extending outward from the tang;
  - a second flange extending outward from the tang opposite the first flange;
  - a third flange spaced apart from the first flange and extending outward from the tang; and
  - a fourth flange spaced apart from the second flange and extending outward from the tang opposite the third flange, wherein the first, second, third, and fourth flanges are connectable to the frame.

2. The bracket of claim **1**, wherein:
- the first and second flanges are disposed orthogonal to a longitudinal axis of the after-treatment component; and
- the third and fourth flanges are disposed at an angle with respect to the longitudinal axis of the after-treatment component.

3. The bracket of claim **2**, wherein each of the first, second, third, and fourth flanges has a bore.

4. The bracket of claim **3**, further including a fastener passing through the bore to connect a link to each of the first, second, third, and fourth flanges, wherein the link is connectable to the frame.

5. The bracket of claim **4**, wherein the pair of legs are disposed parallel to the longitudinal axis of the after-treatment component.

6. The bracket of claim **5** wherein the tang is slidably connected to the clevis.

7. The bracket of claim **6**, wherein the tang is pivotally connected to the pair of legs.

8. The bracket of claim **7**, wherein the angle between each of the third and fourth flanges and the longitudinal axis of the after-treatment component is about 15 to 40°.

9. A bracket for connecting an after-treatment component to a frame, comprising:
- a clevis connectable to the after-treatment component; and
- a front link coupler including:
  - a tang connected to the clevis;
  - a first flange extending orthogonally outward from the tang;
  - a second flange extending orthogonally outward from the tang opposite the first flange;
  - a third flange spaced apart from the first flange and extending outward from the tang; and
  - a fourth flange spaced apart from the second flange and extending outward from the tang opposite the third flange, wherein each of the third and fourth flanges is disposed at an angle of about 15 to 40° relative to a longitudinal axis of the after-treatment component, and wherein the first, second, third, and fourth flanges are connectable to the frame.

10. The bracket of claim **9**, wherein the clevis includes:
- a generally flat clevis base connectable to the after-treatment component;
- a pair of legs extending outward from and orthogonal to the clevis base, the pair of legs being spaced apart to receive the tang therebetween.

11. The bracket of claim **10**, wherein the tang is slidably connected to the clevis and pivotally connected to the pair of legs.

12. The bracket of claim **11**, wherein the front link coupler can withstand thrust loads of about 3 g to 5 g.

13. An exhaust system, comprising:
- an inlet configured to receive exhaust from an engine;
- an outboard plenum configured to direct the exhaust to atmosphere;
- a frame mountable on a mobile machine;
- an after-treatment component mounted on the frame and configured to treat the exhaust received from the inlet before discharging the exhaust via the outboard plenum; and
- a bracket connected to the after-treatment component, the bracket including:
  - a clevis, including:
    - a generally flat clevis base connectable to the after-treatment component; and
    - a pair of legs extending outward from and orthogonal to the clevis base, the pair of legs being disposed parallel to the longitudinal axis of the after-treatment component and spaced apart from each other;
  - a tang connected to the clevis and disposed between the pair of legs of the clevis;
  - a first flange extending outward from the tang;
  - a second flange extending outward from the tang opposite the first flange;
  - a third flange spaced apart from the first flange and extending outward from the tang; and
  - a fourth flange spaced apart from the second flange and extending outward from the tang opposite the third flange; and
- a plurality of links connecting the first, second, third, and fourth flanges to a plurality of locations on the frame.

14. The exhaust system of claim **13**, wherein:
- the first and second flanges are disposed orthogonal to a longitudinal axis of the after-treatment component; and

the third and fourth flanges are disposed at an angle with respect to the longitudinal axis of the after-treatment component.

15. The exhaust system of claim **14** wherein the tang is slidably connected to the clevis.

16. The exhaust system of claim **15**, wherein the tang is pivotally connected to the pair of legs.

17. The exhaust system of claim **16**, wherein the angle between each of the third and fourth flanges and the longitudinal axis is about 15 to 40°.

18. The exhaust system of claim **17**, wherein the tang can withstand thrust loads of about 3 g to 5 g.

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